Teaching material on WP 2.3 ñAssessment of the Bio-based Products Market Potential for Innovationò

Introduction

ñAssessment of the Bio-based Products Market Potential for Innovationòis a report prepared by Pöyry Management Consulting. It is a deliverable of WP2 (Market Assessment and Needs Assessment) of the BIOCHEM project.

The report provides insight into the market potential of bio-based chemicals and into factors that may hinder the exploitation of this potential. The ultimate purpose of the report is to support companies ï particularly SMEs - in making decisions on the potential viability of investments to enter this market, and to provide input for the development of new support tools that will help overcome the main barriers to innovation. It also serves as a reference document for stakeholders in the European Chemicals Industry involved in the development of the bio-based sector as the BIOCHEM project aims at accelerating the growth rate of transnational bio-based businesses.

In terms of scope, the report covers four product segments, namely bio-plastics, bio-lubricants, bio-solvents and bio-surfactants.

The report has as its goal to summarise the current knowledge of the market structure and potential for innovation of the bio-based product sectors. It provides consolidated literature reviews of

- market potential of bio-based products (updated with a Pöyry interpretation of the effects of the world economic crisis) (Chapter 2)
- impacts of this market potential on the environment, on people and on the economy (Chapter 3)
- identified market and technology drivers and barriers (Chapter 4)
- opportunities for platform chemicals (Chapter 5)
- main environmental issues related to bio-based products (Chapter 6)

Moreover, case studies of successful innovation are presented (Chapter 7) and recommendations given to overcome barriers in the bio-based product supply chain (Chapter 8).

Chapter 2. THE WORLD ECONOMIC CRISIS AND ITS EFFECT ON THE STATE-OF-THE-MARKET: A SHORT TO MIDTERM PERSPECTIVE

Chapter 2 of the report provides future growth estimates for bio-based products. The total volume growth of major bio-based chemical groups between 2008-2020 is estimated at 2.1 Mt (5.3% pa). Assuming similar market value growth, the market is estimated to grow from current (2008) 21 billion EUR to 40 billion EUR in 2020. This will increase the market share of bio-based products from 4% in 2008 to 6% in 2020, providing 43,600 new jobs within the biochemical industry only. Future growth will be affected by the cost of biomass feedstocks but also by fossil fuel prices and by the level of public support.

The volume of the European *bio-plastics* market totalled 0.13 Mt in 2008 and is estimated to grow to 0.9 Mt in 2020 (growth rate 16% pa). At the current state of technology, 5-10% of the plastics market could theoretically be bio-plastics and the long-term potential (2030 onwards) is significantly higher (70-100%). In the initial phase of market introduction, products are often used in niche markets, but some bio-based polymer applications have already gained an established position in the market. Recently, it has also become technically feasible to either partially or totally substitute fossil-based raw materials with renewable raw materials in standard and high-performance polymers.

Annual *bio-lubricant* consumption in the EU totalled 0.15 Mt in 2008 and is estimated to grow to 0.23 Mt in 2020 (growth rate 3.6% pa). The current market penetration of bio-lubricants varies considerably within the EU, and not all bio-lubricants are completely vegetable oil-based. Theoretically around 90% of lubricants currently used could be replaced by plant-derived chemicals.

The EU *bio-solvent* consumption totalled 0.63 Mt in 2008 and is estimated to grow annually by 4.8%, reaching 1.1 Mt in 2020.

The consumption of *bio-surfactants* totalled 1.52 Mt in the EU in 2008. Annual growth potential is estimated to be 3.5%, and bio-surfactant potential 2.3 Mt in 2020.

Chapter 3. IMPACTS OF THE POTENTIAL OF THE EUROPEAN BIO-BASED MARKET ON ENVIRONMENT, SOCIETY AND ECONOMY

Chapter 3 gives an overview of the impact of bio-based products on the environment, society and economy. Most bio-based products consume less energy and emit less carbon dioxide than products

produced from fossil resources. Vegetable solvents emit few or no volatile organic compounds; and bioproducts offer potential to reduce the generation of toxic wastes. The social impacts primarily relate to employment creation and the potential for rural development. The economic benefits derive from a growing bio-based products market and the macroeconomic savings of bio-based products when compared to petrochemical based.

Chapter 4. IDENTIFICATION OF MARKET AND TECHNOLOGY DRIVERS AND BARRIERS AND INDUSTRY NEEDS

Chapter 4 focuses on the identification of market and technology drivers, barriers and industry needs.

The expected rapid growth in *bio-plastics* is driven by concerns about oil prices, high technical substitution potential and superior product properties such as biodegradability. Major barriers to market uptake include economic barriers and competition with fossil fuel based plastics, for which the production and end use has been optimised for decades and which are well known in the entire supply chain. There are also challenges in scale-up and in the short term availability of bio-based feedstocks.

The *bio-lubricant* industry is growing based on environmental concerns as some countries have already banned the use of non-biodegradable lubricants in sensitive areas, at least in applications where oils are lost into the soil and surface waters. Other motivations are concerns about oil prices and high technical substitution potential. Bio-lubricants are more expensive than conventional products, which is the major barrier to market uptake. However, the higher cost may be partly offset by the reduced need for replacement due to the longer lifespan of bio-lubricants.

The advantage of *bio-based solvents* is that the vast majority do not emit volatile organic compounds which are harmful to human health. However, bio-solvent production is not currently cost-effective enough to compete with traditional solvent manufacture. Research into the use of bio-solvents in chemical synthesis is advancing, with the successful replacement of organic and halogenated solvents demonstrated for a range of syntheses. The production of common organic solvents from biological feedstocks is also being investigated, allowing bio-solvent production at lower cost and higher purity. Similarly to other product segments, concern about future increases in the price of oil is also a driver for development.

The major drivers in the surfactant market are price, performance and product safety. Advantages of *bio-derived surfactants* include biodegradability, low toxicity and raw material availability as they can be produced from industrial waste or by-products. Similarly to other product segments, concern about future increases in the price of oil is also a driver for development. The major barrier to market uptake is the higher production cost.

Chapter 5. OPPORTUNITIES FOR PLATFORM CHEMICALS AVAILABLE FROM BIO-REFINING TO BE USED AS INGREDIENTS OR STARTING MATERIALS

Chapter 5 summarises the relevance of biomass feedstocks and platform chemicals for the development of the bio-based chemicals sector. The main biochemical feedstock groups are energy crops form both agriculture and aquaculture and biomass residues from agriculture, forestry and industry. At the present time, bio-based production mainly utilises crop feedstocks, but the role of algae in the generation of bio-based feedstock is expected to increase in the future.

Most bioproducts of biotechnology are based on C_6-sugar. Sugar consumption for the production of biochemicals will increasingly compete with the food and biofuel industry. This may result in a rising cost of sugar and a societal discussion about land use for food and fuel. Limited sugar availability is already a driver for the use of lignocellulosic carbon sources such as waste biomass from agriculture or forest biomass.

The concept of biorefineries is a combination of integrated plants addressing the processing and fractionation of renewable raw materials, transforming feedstocks into various products. Sugars, oils and other compounds in biomass can be converted directly into platform chemicals or chemical building blocks or as by-products from fuel production processes analogous to the petrochemical industry today. New advanced biorefinery concepts are still mostly in the R&D, pilot or small-scale demonstration phase. It is expected that these new concepts will be implemented in the market in the medium term (2013-2020).

In the biofuel sector production is generally located where feedstock costs are lowest. This may have an impact on the geographical distribution of biochemical production.

Chapter 6. KEY INFORMATION ON ENVIRONMENTAL ISSUES

Chapter 6 focuses on the mechanisms available for demonstrating the properties and environmental competitive advantages of the bio-based sector. These include life cycle assessment, environmental technology verification, standardisation, certification and eco-labels.

Chapter 7. PRESENTATION OF CASE STUDIES DEMONSTRATING SUCCESSFUL INNOVATION

Chapter 7 presents examples of successful and innovative bio-based products in the form of selected case studies.

Chapter 8. CONCLUSIONS AND RECOMMENDATIONS TO OVERCOME BARRIERS TOWARDS INNOVATION IN THE BIOCHEMICAL SUPPLY CHAIN

Chapter 8 includes the recommendations. They can be summarised as follows:

1. Attitudes
    - Public risk funding should actually take risks and expect a high failure ratio for every big success.
2. R&D, education and open innovation
    - IPR support (expertise and funding) for SMEs and matching of SME IPR by public/private agencies.
    - Establishment of European Bioacademies: Networks of universities, research institutes and companies including SMEs, where graduate schools with e.g. public/private funding would have students getting their doctorates and post-doctoral merits solving problems provided by groupings of SMEs.
    - Establishment of a Biochemical Open Innovation Forum to distribute ideas and innovation and make them available to those who may be able to turn them into world-class products and services.
3. Financing
    - Provision of a rich array of public, public/private and angel instruments for SMEs.
4. Networking and roles in the supply chain
    - Support for building cooperations networks and supply chains.
    - Establishment of biomaterials exchanges, where, with public/private sponsorship, biomaterial developers and end use sectors would meet.
5. Scalability and markets
    - Improving access to specialist demonstration facilities for proof of principle.
    - Creation of tools for management/financial evaluation and market assessment support at an early stage to SMEs.
    - Implementation of policies related to measures reducing production costs (e.g. tax incentives) at an early market stage

- Support to accompanying policies (climate change, agriculture, forestry) at a mass market stage in order to guarantee the realisation of positive external effects and to avoid the risk of insufficient supply of raw materials.

- Development of tools and support for sustainability policies and sustainability argumentation: environmental, social, and economic.

6. Regulation and standardisation

    - Identifying key EU regulation in areas relevant to bio-based chemicals,

    - Identifying the elements that best promote SME success, and

    - Introducing consistency and clarity.